## Chapter 7: Public Health and Aquatic Life Concerns

**Objective: Evaluate fish tissue contamination, update advisories and provide public education.**

**Indicator Development*: Report on priority setting and data development needs for fish consumption advisories.**
** NEPPS indicator provides overview of priorities/ data development needs related to fish consumption advisories.*

### 7.1 Fish Consumption Designated Use Assessment

As far back as 1976 NJDEP instituted a comprehensive program to survey possible contamination of fish and shellfish in New Jersey waters. Although some contaminated fish and shellfish species in certain drainages have been identified (See Tables 7.1.2a,b below) most fish species and waterways in New Jersey do not have fish consumption advisories. Original efforts (Belton 1982) evaluated a broad spectrum of fish including species of recreational and commercial importance as well as species used as ecological indicators. Sampling locations included all major drainage basins, locations containing known or suspected sources of PCB contamination or locations important to recreational and commercial fisheries. These initial results showed PCB contamination to be present only in certain species of fish with fatty edible tissue (e.g., striped bass, bluefish, American eel) whereas other important recreational and commercial foodfish were not contaminated (e.g., summer and winter flounder, weakfish, smallmouth and largemouth bass, perch, carp, etc.). Saltwater and migratory species (e.g., eel) tended to have higher concentrations than freshwater species. In addition, most waterways of the state did not have contaminated fish whereas certain geographical areas with a few species showed levels of concern ostensibly due to localized sources. Subsequent monitoring activities were then targeted at these species and drainages.

This comprehensive approach followed by intensive localized monitoring was used again in the late 1980s when Dioxins in fish became an environmental and health concern (Belton 1985) as well as again in the 1990s when mercury in finfish was discovered and heath advisories posted (NJDEP 1994). In general, concentrations of various persistent chemical *contaminants are* often highest in animals at the top of the food chain (e.g., apex fish and wildlife species), and fish from a number of sites around the state have been shown to contain contaminant concentrations above both federal and/or state thresholds. Identification of these findings prompted the NJDEP and the Department of Health and Senior Services to issue health advisories on the consumption of several species of fish from throughout the state targeted as specific waterways. Some species which are migratory (e.g., American ell) which will pick up PCBs downstream in urban areas and then migrate upstream were given "Statewide" consumption advisories (i.e., even though fish were only analyzed from the estuaries) to conservatively protect fishermen/consumers upstream even though the contamination did not necessarily reflect local sources or conditions of water quality. These advisories are routinely listed at the NJDEP Website (i.e., *www.state.nj.us/dep/fgw*) and in the New Jersey Fish and Wildlife Digests (NJDEP 2000a and NJDEP 2000b).

From the perspective of "fishable waters" some of these waterways, listed for advisories, may have fish perfectly suitable for recreational purposes (i.e. based on Fish and Game Rules: (NJDEP 2000a and b) and/or safe to eat (i.e., based on health advisory information: NJDEP 2000a and b) or contaminated but subject to common catch-and-release programs. Tolerant species such as carp may live in degraded waters at safe levels of contamination and therefore satisfy both public health and aquatic life concerns. Individual Use Support Summaries for waterways affected by fish consumption advisories are listed in Part I-Executive Summary of this document and in Tables 7.1-2a,b below.

### 7.1.1 Fish Consumption Designated Use Assessment Method

We must recognize that using fish consumption advisories as indicators of local water quality is somewhat problematic. That is, assigning a waterway where contaminated fish may have been caught (using a sampling/assessment methodology designed to evaluate impacts to consumers) may not be directly correlated with water quality degradation in a specific stream reach. IN addition, finfish, within certain limitations, are extremely mobile making associations with sources and causes often tenuous. Also, differing specie physiology and contaminant properties (e.g. only fatty muscle accumulates organochlorides) may result in only certain fish within a waterway presenting public health concerns whereas other fish are completely safe to eat.

Much of the data used to establish the fish consumption advisories in New Jersey are over five years old. Specifically, all PCB/dioxin/pesticide based advisories are from the mid-1980s. Recognizing that this data is old and that the sources of the bioaccumulated contaminants have been subjected to regulatory source reduction over the ensuing years, NJDEP views these advisories as based on *evaluated data* thereby listing the affected waterways uses as "threatened" (at least until additional data is collected - see below). Fish consumption advisories based on *monitored data* (data collected within the last five years) in New Jersey is limited to mercury contamination and NJDEP views these data to establish "not supporting" or "partially supporting" uses (See Table 7.1-2). It should be noted however that the primary source of mercury contamination is atmospheric deposition associated with coal fired power plant emissions. Source reduction strategies targeted at these are multi-media in nature. The funding to address these data gaps and routinely update advisories as needed has not been available for several years. A continuous stable source of funding to maintain the State's monitoring of fish and waterways impacted by consumption advisories should be established. In fiscal year FY 1998 a one-time special NJ appropriation was established for NJDEP to study chemical contamination in the State's fisheries allowing both data sets to be selectively re-assessed via new monitoring in FY1999 and FY2000.

| Table 7.1-1: Fish Consumption Use Assessment Criteria | |
|---|---|
| **EPA Designated Use Support** | **Criteria** |
| **Full Support** | No fish restrictions or bans in effect (1) OR monitoring of fish tissue may show contaminants present but not exceeding levels of concern. |
| **Full Support but Threatened** | Monitoring of fish tissue reveals contaminant levels with trends towards or away from levels of concern OR data more than five years old (2). |
| **Partial Support** | "Restricted Consumption" of fish in effect (restricted consumption defined as limits on the number of meals or size of meals consumed per unit time for one or more fish species); or a fishing ban is in effect for a sub-population that could be at potentially greater risk for one or more fish species. |
| **No Support** | "No consumption", or fishing ban in effect for general population for one or more fish species; or commercial fishing ban in effect. |
| (1) Note: Consumption Standards: Fishing advisories are measured against USFDA Tolerances for contaminated food as well as NJ risk assessments performed by Toxic in Biota Committee a joint effort between the NJDEP and the NJ Department of Health and Senior Services.<br>(2) Data Sources: Much of the PCB/dioxin/pesticide data are old (1980s). Much of the mercury data is more recent (1990s). Both data sets are being selectively re-assessed via new monitoring.<br>Spatial Extent: Statewide (select species), regional (Pinelands) or site specific (individual lakes). | |

### 7.1.2 Fish Consumption Designated Use Assessment

NJDEP participates in an Interagency Toxics in Biota Committee (TIBC) that focuses on toxic contamination in fish tissue that may be of concern to human health. As funds are available, NJDEP's Division of Science, Research and Technology conducts research projects to evaluate levels of contaminants in fish, shellfish and crustacea. As needed, fish consumption advisories are developed through the TIBC to protect human health.

In the mid-1980's, the NJDEP found elevated levels of PCBs, dioxins and pesticides (primarily chlordane) in finfish, lobsters, eels and crabs collected from New York-New Jersey interstate waters and from the Delaware River Estuary. In order to protect human health, commercial fishing bans and recreational fishing advisories have been issued by the State for affected species and waterways. Through a special appropriation from Governor Whitman, a study is being conducted to collect current data and update these advisories as appropriate.

More recently, New Jersey became one of 33 states that have enacted fish consumption advisories in response to mercury contamination. These consumption advisories have been issued for species consumed by recreational anglers (chain pickerel and largemouth bass), not commercially available species. Drinking water supplied from the affected waters has been tested and shown to be safe because the mercury resides primarily in sediments and aquatic life.

New Jersey shares mid-river jurisdictional waters with New York in the northern watersheds and Delaware/Pennsylvania in the south. Extensive cooperation and peer-review between states occurs in data analysis and in the formulation of each state's fish consumption advisories. These primarily affect national estuarine areas (NY-NJ Harbor Estuary and Delaware Estuary). For

example, in the Delaware Estuary NJDEP, after reviewing the risk-based consumption advisories developed by Delaware's DNREC, amended its own Fish and Game guidance (NJDEP 2000aand b) for Delaware Bay waters to reflect the same guidance for Delaware anglers.

This year NJDEP is cooperating with a DRBC study describing the existing approaches to developing fish consumption advisories in the Delaware Estuary, the available data on contaminant levels in estuary fish, trends for specific contaminant and species, and opportunities for developing a unified program for the Delaware Estuary (i.e., summary report available 9/00).

In marine waters NJDEP as been instrumental in developing Coastwide fish-consumption advisories for bluefish an important recreational/commercial species, which is migratory from Florida to Maine. In 1986, after announcing NJ consumption advisories, NJDEP in conjunction with all the Atlantic States Environmental and Health Departments organized, designed and successfully sought federal funding for a Coastwide bluefish study. The study performed by NOAA and EPA showed that contaminated bluefish posed the same consumer risk no matter where they were caught in any Atlantic State jurisdictional. Individual states followed with regulatory risk analyses and consumption advisories consistent with New Jersey's

Application of the results of these studies to designated use attainment must be done with caution due to the following issues:

- Fish tissue monitoring is complex and expensive, hence, studies are often conducted only where fish tissue contamination issues is suspected and commercial or recreational fishing occurs. Therefore, a statewide overview of the magnitude and severity of this problem is not discernable from the data set.
- Fish are mobile animals and may have become contaminated in New Jersey waters or elsewhere.
- Pollution sources may be local (e.g., chlordane) or primarily transported from other states (e.g., mercury).
- Fish consumption advisories include provisions to protect sensitive populations (e.g., pregnant women, nursing mothers, small children).
- Several fish advisories are based on data that are more than 10 years old. A study is underway to collect current data to update and revise these advisories as appropriate.

Fish consumption advisories that apply to New Jersey waters are summarized in the following Tables 7.1-2a and 7.1-2b.

**Table 7.1-2a: Fish and Crab Advisories Based On PCBs, Dioxin or Chlordane Contamination**

| LOCATION/ SPECIES | POLLUTANT | ADVISORY/PROHIBITION | |
|---|---|---|---|
| | | General Population | High Risk Individual[1] |
| ***NEW JERSEY-STATEWIDE***<br>Note: local advisories may be more specific for the same species. | | | |
| American eel | PCBs | do not eat more than once a week | do not eat |
| Bluefish (over 6 lbs.) | PCBs | do not eat more than once a week | do not eat |
| Striped bass* | PCBs | consumption advisories vary by area; see below | consumption advisories vary by area; see below |
| American lobsters | PCBs | do not eat green glands (hepatopancreas) | do not eat green glands |
| ***NEWARK BAY COMPLEX***<br>Newark Bay, Hackensack River downstream of Oradell Dam, Arthur Kill, Kill Van Kull, tidal portions of all rivers and streams that feed into these water bodies. | | | |
| Striped bass* | PCBs/Dioxin | do not eat | do not eat |
| American eel | PCBs | do not eat more than once a week | do not eat |
| Blue crab* | PCBs/Dioxin | do not eat or harvest[2] | do not eat or harvest[2] |
| Bluefish (over 6 lbs.), white perch, white cat fish | PCBs | do not eat more than once a week | do not eat |
| ***NEWARK BAY COMPLEX***<br>Passaic River downstream of Dundee Dam and streams that feed into this section of the river. | | | |
| all fish and shellfish* | Dioxin | do not eat | do not eat |
| blue crab * | PCBs/Dioxin | do not eat or harvest[2] | do not eat or harvest[2] |

| LOCATION/ SPECIES | POLLUTANT | ADVISORY/PROHIBITION | |
|---|---|---|---|
| | | General Population | High Risk Individual[1] |
| ***HUDSON RIVER*** Hudson River includes the river downstream of NY-NJ border (about 4 miles above Alpine, NJ | | | |
| American eel * | PCBs | Do not eat more than once a week | Do not eat |
| Striped bass * | PCBs | Do not eat more than once a week | Do not eat |
| Bluefish (over 6lbs.) white perch and white catfish | PCB | Do not eat more than once a week | Do not eat |
| Blue crab | PCBs/Dioxin | Do not eat green gland (hepatopancreas)[3] | Do not eat green gland [3] |
| ***RARITAN BAY COMPLEX*** This complex includes the New Jersey portions of Sandy Hook and Raritan bays, the tidal portions of the Raritan River (downstream of the Rte. 1 bridge in New Brunswick) and the tidal portions of all rivers and streams that feed into these water bodies. | | | |
| Striped bass * | PCBs | Do not eat more than once a week | Do not eat |
| Bluefish (over 6 lbs.), white perch and white catfish | PCBs | Do not eat more than once a week | Do not eat |
| Blue crab | PCBs/Dioxin | Do not eat green gland (hepatopancreas)[3] | Do not eat green gland (hepatopancreas)[3] |
| ***NORTHERN COASTAL WATERS*** This area includes all coastal waters from Raritan bay south to the Barnegat Inlet. | | | |
| Striped bass * | PCBs | Do not eat more than once a week | Do not eat |
| ***CAMDEN AREA*** This area includes Strawbridge Lake, Pennsauken Creek (north and south branches), Cooper river and its drainage, Cooper River Lake, Stewart Lake and Newton Lake. | | | |
| All fish, shellfish and crustaceans * | Chlordane | Do not eat | Do not eat |

| LOCATION/ SPECIES | POLLUTANT | ADVISORY/PROHIBITION | |
|---|---|---|---|
| | | General Population | High Risk Individual[1] |
| ***LOWER DELAWARE RIVER & BAY***<br>Delaware River from Yardley, PA to the PA/DE border | | | |
| American eel | PCBs, Chlordane | Do not eat | Do not eat |
| ***LOWER DELAWARE RIVER & BAY***<br>Delaware River from Yardley, PA (across from Ewing Twp., NJ) south to the Chesapeake and Delaware Canal | | | |
| Channel catfish *<br>White catfish<br>White perch | PCBs, Chlordane | Do not eat<br>Do not eat<br>Do not eat | Do not eat<br>Do not eat<br>Do not eat |
| ***LOWER DELAWARE RIVER & BAY***<br>Lower Delaware River includes the river between the PA Turnpike Bridge (I-276 bridge) in Burlington Twp. (Burlington County) and Birch Creek in Logan Twp. (Gloucester County about 2 miles below Commodore Barry Bridge | | | |
| Channel catfish * | PCBs, Chlordane | Do not eat | Do not eat |
| **Lower Delaware River & Bay**<br>Delaware River from the DE/PA border south to the Delaware and Chesapeake Canal | | | |
| Striped bass * | PCBs | Do not eat | Do not eat |
| **Lower Delaware River & Bay**<br>Delaware River from the Chesapeake and Delaware Canal (across from Salem, NJ) south to mouth of the Delaware Bay | | | |
| Striped bass *<br>Channel catfish<br>White catfish | PCBs | Do not eat more than five 8-ounce meals per year | Do not eat more than 3 4- ounce meals per year |

* Selling any of these species from designed water bodies is prohibited in New Jersey.

[1] High-risk individuals include infants, children under the age of 15, pregnant women, nursing mothers and women of childbearing age. They are advised not to eat any such fish or crabs taken from the designated regions since these contaminants have a greater impact on the developing young.

[2] No harvest means no taking or attempting to take any blue crabs from these waters.

[3] Interim recommendation based on research showing elevated levels of chemical contaminants in the blue crab hepatopancreas also called the green gland.

**Table 7.1-2b: Consumption Advisories for Mercury for Largemouth Bass and Chain Pickerel from New Jersey Freshwaters**

| Location | Species | Advisory + General Population | Advisory + High-Risk Individual* |
|---|---|---|---|
| **New Jersey Statewide** | | | |
| For all freshwater bodies (except those listed below) | Bass and pickerel | do not eat more than once a week | do not eat more than once a month |
| **Pinelands Area** | | | |
| For all water bodies (except those listed below) | Bass and pickerel | do not eat more than once a month | do not eat |
| **Site-Specific Pinelands** | | | |
| Lake Lenape | Bass<br>Pickerel | do not eat more than once a week<br>do not eat more than once a week | Do not eat<br>do not eat more than once a month |
| Mirror Lake | Bass<br>Pickerel | No restrictions<br>No restrictions | do not eat more than once a month<br>do not eat more than once a week |
| Stafford Forge | Bass<br>Pickerel | do not eat more than once a month<br>do not eat more than once a week | Do not eat<br>Do not eat |
| Wading River | Bass<br>Pickerel | do not eat more than once a month<br>do not eat more than once a week | Do not eat<br>Do not eat |
| **Site-Specific Statewide** | | | |
| Assunpink Creek | Bass<br>Pickerel | No restrictions<br>Do not eat more than once a week | Do not eat more than once a week<br>Do not eat more than once a month |
| Atlantic City Reservoir - No Fishing Allowed | Bass<br>Pickerel | Do not eat<br>Do not eat | Do not eat<br>Do not eat |
| Big Timber Creek | Bass<br>Pickerel | No restrictions<br>do not eat more than once a week | do not eat more than once a week<br>do not eat more than once a month |
| Canistear Reservoir | Bass<br>Pickerel | do not eat more than once a week<br>do not eat more than once a week | Do not eat<br>Do not eat more than once a month |
| Clinton Reservoir | Bass<br>Pickerel | do not eat more than once a week<br>do not eat more than once a week | do not eat<br>do not eat more than once a month |
| Cranberry Lake | Bass<br>Pickerel | do not eat more than once a week<br>No restrictions | do not eat more than once a month<br>do not eat more than once a month |

| Location | Species | Advisory + General Population | Advisory + High-Risk Individual* |
|---|---|---|---|
| Crosswicks Creek | Bass<br>Pickerel | No restrictions<br>do not eat more than once a week | do not eat more than once a week<br>do not eat more than once a month |
| Crystal Lake (Burlington County) | Bass<br>Pickerel | No restrictions<br>Do not eat more than once a week | do not eat more than once a week<br>do not eat more than once a month |
| Delaware River (Easton to Trenton) | Bass<br>Pickerel | No restrictions<br>Do not eat more than once a week | do not eat more than once a month<br>do not eat more than once a month |
| Delaware River (Trenton to Camden) | Bass<br>Pickerel | No restrictions<br>do not eat more than once a week | do not eat more than once a week<br>do not eat more than once a month |
| Lake Carasaljo | Bass<br>Pickerel | do not eat more than once a week<br>No restrictions | Do not eat<br>do not eat more than once a month |
| Lake Hopatcong | Bass<br>Pickerel | No restrictions<br>No restrictions | do not eat more than once a month<br>do not eat more than once a month |
| Manasquan Reservoir | Bass<br>Pickerel | do not eat more than once a month<br>do not eat more than once a week | Do not eat<br>do not eat more than once a month |
| Merrill Creek Reservoir | Bass<br>Pickerel | do not eat more than once a week<br>do not eat more than once a week | Do not eat<br>do not eat more than once a month |
| Monksville Reservoir | Bass<br>Pickerel | do not eat more than once a week<br>do not eat more than once a week | Do not eat<br>Do not eat more than once a month |
| Rockaway River | Bass<br>Pickerel | do not eat more than once a week<br>No restrictions | Do not eat more than once a month<br>Do not eat more than once a month |
| Round Valley Reservoir | Bass<br>Pickerel | No restrictions<br>do not eat more than once a week | do not eat more than once a month<br>do not eat more than once a month |
| Shadow Lake | Bass<br>Pickerel | No restrictions<br>do not eat more than once a week | do not eat more than once a week<br>do not eat more than once a month |
| Spruce Run Reservoir | Bass<br>Pickerel | No restrictions<br>do not eat more than once a week | do not eat more than once a month<br>do not eat more than once a month |

| Location | Species | Advisory +<br>General Population | Advisory +<br>High-Risk Individual* |
|---|---|---|---|
| Swartswood Lake | Bass<br>Pickerel | Do not eat more than once a week<br>No restrictions | do not eat more than once a month<br>do not eat more than once a week |
| Union Lake | Bass<br>Pickerel | do not eat more than once a month<br>do not eat more than once a month | Do not eat<br>Do not eat |
| Wanaque Reservoir | Bass<br>Pickerel | do not eat more than once a week<br>do not eat more than once a week | Do not eat<br>Do not eat |
| Wilson Lake | Bass<br>Pickerel | do not eat more than once a week<br>do not eat more than once a week | Do not eat more than once a month<br>Do not eat |
| Woodstown Memorial Lake | Bass<br>Pickerel | No restrictions<br>do not eat more than once a week | do not eat more than once a month<br>do not eat more than once a month |
| Notes: + One meal is defined as an eight-ounce serving.<br>* High risk individuals are pregnant women, women planning pregnancy within one year, nursing mothers and children under five years old. | | | |

The Bound Brook and New Market Lake became contaminated from releases of the Cornell Dublier Electronics Superfund Site, located about one-mile upstream of the lake, resulting in contaminated sediments and fish. In 1997, the Department issued a ban on consumption of any fish from the Bound Brook and New Market Lake. The ongoing remediation of this site is being managed by the USEPA.

### 7.1.3 Data Development Needs

As stated above, State issued advisories relative to PCB's and chlorinated pesticides are based on data that are over five years old and fish tissue contamination data have not been collected from all waterbodies or species that are consumed by New Jersey recreational and commercial anglers. Funding to address these data gaps and routinely update advisories as needed has not been available for several years. In FY 1999 and FY 2000 a one-time special NJ investigation of chemical contamination in State's fisheries will be performed including those marine and estuarine fish and shellfish and freshwater fish under current fish consumption advisories. The results of this study will be used to repeal or amend existing advisories or if necessary develop new advisories. In addition, the data generated will also assist the DEP to evaluate trends in contaminant concentrations of these selected species. The outcome of this study will facilitate the development of NEPPS milestones and indicators relative to fish consumption. In concordance with this status and trends monitoring a stable source of funding should be identified to support this important public health and aquatic life indicator.

#### 7.1.3.1 Risk Assessment Needs

Development of a more comprehensive health assessment of contaminants in fish species that are consumed by New Jersey anglers is a significant risk assessment need. Recent data from EPA on new risk factors for some chemicals of concern as well as the use of Toxic Equivalent Factor (TEQ) approaches towards assessing cumulative risk from more congeners of PCBs and dioxins may be indicated.

#### 7.1.3.2 Understanding Factors that Influence Bioaccumulation

Several environmental factors influence patterns of chemical bioaccumulation, including the age, lipid content and species of fish and a variety of water quality parameters (e.g., pH, dissolved organic carbon, calcium, etc.). Improved understanding of how these factors interplay will enhance our ability to predict spatial patterns of contamination, and thus the development of appropriate advisories and contaminant management measures.

#### 7.1.3.3 Identifying Sources of Chemical Contamination

The results of ongoing studies will be used to evaluate the basis for existing fish consumption advisories, evaluate risks associated with contamination, and identify sources of toxic contamination. Efforts to address significant data gaps will be conducted, as resources become available. There are numerous suspected sources of toxic chemicals that bioaccumulate in fish and shellfish, including historical and current sediment contamination, air deposition, combined sewer overflows, municipal stormwater, agricultural -runoff and various point source discharges. In order to reduce contamination in fisheries and therefore reduce the need for consumption advisories, levels environmental contamination must be reduced. Identification of specific sources of toxic contamination and data regarding the relative contribution of each source is the first step toward appropriate management.

Before and after fish advisories are put in place NJDEP continuously looks for localized or downstream sources of contamination. In both the Delaware Estuary and the Harbor Estuary Programs NJDEP is currently developing Pilot Studies for Source Trackdown using GIS-based data searches (Belton and DeFina 2000) and bald eagles (Niles et al. 2000) as bioindicators of PCB contamination. In other waters NJDEP also participates in the trackdown of un-permitted discharges of contaminants in conjunction with the Department's land use regulation program (e.g. CSO Sampling workplans, enforcement follow-up, etc.).

Air deposition is a likely source for significant loads of some bioaccumulative contaminants (e.g., mercury, PCBs, etc.). To investigate and track these sources NJDEP has established the New Jersey Atmospheric Deposition Network (NJADN) through Rutgers University to monitor nine stations statewide for air toxics. These data will support evaluation of multi-media transport mechanisms useful in understanding certain sources of bioaccumulation (e.g., a major sources of mercury causing NJ fish advisories are coal fired power plants in the Ohio River valley). To address these sources NJDEP is participating in litigation to reduce stack emissions of metals from these out-of-state power plants. NJDEP also organized an *Air-Water Deposition Workshop* held in April of FY 2000 to review existing air-water data and to address how these data can be used to develop air-water science-based management strategies (report due out in Fall 2000). It was noted that water-based TMDLs supply a mechanism to limit permitted sources to

waterbodies and that the Clean Air Act's "Great Waters Program" allow agencies to seek regulatory action against air emission sources through stack permit/controls if links are found between the two media. In addition NJDEP is participating in multi-state TMDL modeling efforts (i.e., DelEP and HEP) to link hydrological transport models with air, water, and sediment data inputs and subsequent with outputs to a food chain transport model (i.e., bioaccumulation).

### 7.1.4 Maintaining and Improving Aquatic Life and Addressing Public Health Concerns

Improve the basis for fish consumption advisories: New bioaccumulation data sets will be developed based on recent sampling events to evaluate the status of existing advisories. Additional studies of fish and shellfish population data, water/sediment chemistry will be collected and collated to evaluate/improve sampling study designs, update advisories and provide public education:

Develop a "fishable index": NJDEP is developing a fishable index that considers fish and shellfish population and consumption issues. From the perspective of "fishable waters" some of these waterways, listed for advisories, may have fish perfectly suitable for recreational purposes and/or safe to eat or contaminated but subject to common catch-and-release programs. Development of a fishable index will consider all of these uses and will be reported in the next Water Quality Inventory Report.

Continue to monitor for sources: NJDEP is currently developing Pilot Studies for Source Trackdown using GIS-based data searches and bald eagles and bioindicators for bioaccumulated contaminants. NJDEP will also participate in the trackdown of un-permitted discharges of contaminants in conjunction with the Department's land use regulation program (e.g. CSO Sampling workplans, enforcement follow-up, etc.).

Monitor and assess air deposition sources: Air deposition is a likely source for significant loads of some bioaccumulative contaminants (e.g., mercury, PCBs, etc.). To investigate and track these sources NJDEP has established the New Jersey Atmospheric Deposition Network (NJADN) to evaluate air data to support evaluation of multi-media transport mechanisms useful in understanding certain sources of bioaccumulation. . In addition NJDEP is participating in multi-state TMDL modeling efforts (i.e., DelEP and HEP) to link hydrological transport models with air, water, and sediment data inputs and subsequent with outputs to a food chain transport model (i.e., bioaccumulation).

Stable sources of funding: Funding to address data gaps and routinely update fish consumption advisories has not been available for several years. In fiscal year FY 1998 a one-time special NJ appropriation was established for NJDEP allowing a selective reassessment via new monitoring in FY1999 and FY2000. A continuous stable source of funding to maintain the State's monitoring of fish and waterways impacted by consumption advisories should be established.

## 7.2 Shellfish Consumption Designated Use Assessment

**Shellfish Consumption Designated Use Milestone:** By 2005, 90% of New Jersey's classified waters will provide shellfish that are safe to harvest.

The National Shellfish Sanitation Program (NSSP) collects data on the levels of total coliform in shellfish and waters that are harvested for shellfish. These data were used to develop the shellfish consumption portion of the fish and shellfish consumption designated use assessment and will be reported as an environmental indicator in the future. This network has not changed since the 1996 Water Quality Inventory Report. The total coliform standard has always been recognized by the NSSP and the Interstate Shellfish Sanitation Conference as a safe and effective means of classifying shellfish waters.

### 7.2.1 Shellfish Consumption Designated Use Assessment Method

The Department monitors the sanitary quality of estuarine and ocean waters by observing measurements of coliform bacterial concentrations (indicators of the presence of pathogens) in the water column and uses the results to classify bay, estuarine and ocean waters for shellfish harvesting. The data are analyzed for compliance with federal standards. In addition, shoreline surveys and hydrographic tracing are performed to identify pollution sources. Monitoring is focused on areas with the potential for a harvestable shellfish resource.

Waters in compliance with standards are open for shellfish harvest (*Approved* areas). Waters partially in compliance may be open seasonally or opened under special conditions (i.e., the shellfish are relayed to regions with good quality water and harvested after 30 days, to allow for purging of harmful pathogens). These areas are designated *Special Restricted* areas. Waters with significantly elevated bacterial levels are permanently closed to shellfish harvest (*Prohibited* areas). The total coliform criteria for each classification are listed in Table 7.2.1-1. (See figure A7.2.2-1 for shellfish classification areas.) Areas around known pollution sources, such as sewage outfalls and marinas, are automatically closed and classified as *Prohibited.* These areas may not be closed due to existing water quality but rather are a preventive measure to protect human health. If an emergency such as a bypass or break in a pipe occurs, these *Prohibited* areas provide for adequate protection of public health. Those areas assessed as "Approved" are reported as Fully Supporting the designated use while "Specially Restricted" or "Seasonally Approved" waters are reported as Partial Support and "Prohibited" areas are reported as No Support (Table 7.2.2-1).

**Table 7.2.1-1 Shellfish Consumption Assessment for bays, estuaries and open ocean waters**

| 305(b) | NSSP | Criteria |
|---|---|---|
| **Full Support** | **Approved** | Geometric mean MPN less than or equal to 70 per 100mL and the estimated 90$^{th}$ percentile does not exceed an MPN of 330 per 100mL |
| **Partial Support** | **Specially Restricted or Seasonal** | Geometric mean MPN greater than 70 but less than or equal to 700 per 100mL and the estimated 90$^{th}$ percentile does not exceed an MPN of 3,300 per 100mL |
| **No Support** | **Prohibited** | Geometric mean MPN exceeding 700 per 100mL and the estimated 90$^{th}$ percentile greater than an MPN of 3,300 per 100mL |

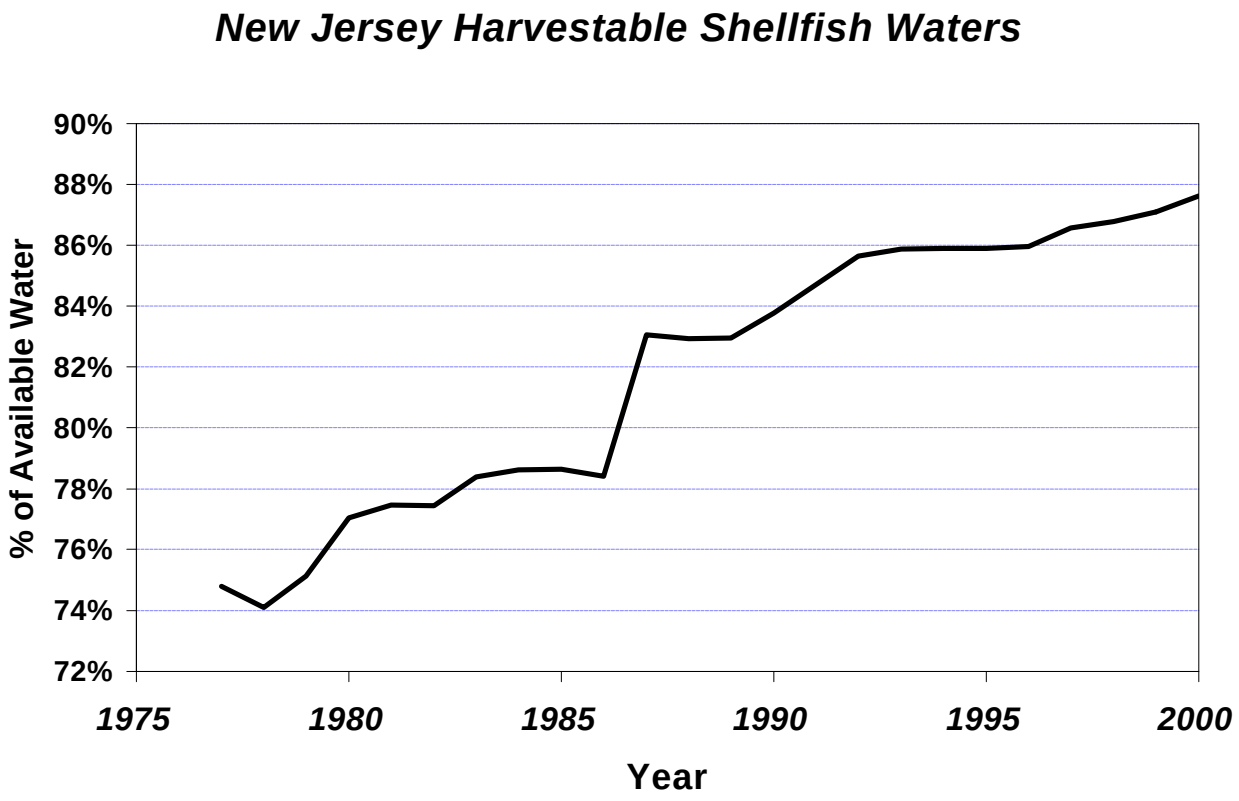
*Notes:*
*Approved* waters are harvestable without restriction.
*Seasonal* waters that are open seasonally typically opened in the winter.
*Specially Restricted* requires relay or depuration prior to harvest.
*Prohibited* waters that are closed to the harvesting of shellfish.

### 7.2.2 Shellfish Consumption Designated Use Assessment Results

Currently, about 2,500 stations are used to monitor 1,053 square miles of waters classified for shellfish harvest in the Shellfish Sanitation Program. These stations are sampled between five and twelve times each year for total coliform and fecal coliform bacteria.

New Jersey has been a national leader in maintaining and enhancing waters available for shellfish harvest. The shellfish waters that support harvesting have increased from 75% in 1977 to 86% in 1996, to 87% in 1998 and 88% in 2000. (See figure 7.2.2-2).

**Figure 7.2.2-2**




*Bay and estuary waters*- Approximately 456 square miles (74%) of bay and estuary waters have the sanitary quality sufficient to fully support open shellfish harvesting, while 115 square miles (19%) partially support this use through seasonal harvesting or harvesting following relay or depuration. The shellfish harvesting in the remaining 43 square miles (7%) is prohibited. These waters do not have the sanitary quality required to support harvesting or are closed to harvesting as a precautionary measure in the vicinity of sewer outfalls or marinas and are identified as No Support.

*Ocean*- In the ocean waters, 352 square miles (78%) fully support shellfish harvesting while 87 square miles (20%) do not support the use. As explained above, the 87 square miles includes areas around sewage outfalls where water quality is sufficient to support shellfish harvesting but are closed as a precautionary measure.

Waters that fully and partially support shellfish harvest are considered safe for harvest. Shellfish taken from these waters may be consumed with or with out additional safety measures. These areas account for 923 sq. miles (808 full support and 115 partial support) or 88% of the total area assessed.

Waters that fully and partially support shellfish harvest are considered safe for harvest. Shellfish taken from these waters may be consumed with or with out additional safety measures. These areas account for 923 sq. miles (808 full support and 115 partial support) or 88% of the total area assessed. Based on 2000 data, 923 square miles (88%) of New Jersey's classified ocean, estuarine and bay waters provide shellfish that are safe to harvest, and 130 square miles (12%) do not support shellfish harvest. Results for 2000 are presented in Table 7.2.2-1.

**Table 7.2.2-1: Shellfish Consumption Designated Use Attainment (in square miles, % of total)[1]**

| | **Full Support** | **Partial Support** | **No Support** | **Total Assessed** |
|---|---|---|---|---|
| **Bay and Estuary** | 456 (74%) | 115 (19%) | 43 (7%) | 614 |
| **Ocean** | 352 (80%) | 0 (0%) | 87 (20%) | 439 |
| **Total** | **808 (77%)** | **115 (11%)** | **130 (12%)** | **1053** |

Notes: This assessment includes waters of NJ, which are also assessed and reported to USEPA by DRBC and ISC. NJ will work with RTI to identify waters, which are assessed by multiple entities to eliminate double counting these waters in the national 305(b) Report.
[1]Data are reported in square statute miles and as a percent of the total area assessed.
*Full Support (Approved)*: waters are harvestable without restriction.
*Partial Support (Specially Restricted/Seasonal):* waters that are open seasonally or require relay and depuration prior to harvest.
*No Support (Prohibited):* waters that are closed to shellfish harvesting. Areas around known pollution sources, such as sewage outfalls and marinas, are automatically classified as no support.

### 7.2.3 Shellfish Consumption Source and Cause Assessment

As part of *The 1995 National Shellfish Register* (NOAA 1997) NJDEP's Bureau of Marine Water Monitoring supplied information to NOAA on individual shellfish growing areas within State jurisdictional waters. They were also asked to identify the presence of twelve different sources of pollution including agricultural feedlots and Marinas grouped into three broader categories: point, nonpoint and upstream sources. In estuarine waters, marinas, boating, urban runoff and stormwater were identified as major contributing factors impacting on shellfish. In Offshore/Ocean waters, direct discharges from ocean outfalls may present localized impacts and nonpoint source urban runoff continues to have a negative impact. See Table A7.2.3-1 for a summary of these results.

There has been a trend toward general improvement in water quality in the estuaries since the domestic waste discharges were relocated to offshore areas. In addition, many previously unsewered areas have become sewered. There are still a few isolated instances where water

quality is still adversely affected by input of inadequately treated domestic waste. Repeated overflows and bypasses from the Monmouth County Bayshore Outfall Authority in northern Monmouth County resulted in the prohibition of harvesting in the western portion of Raritan Bay which had previously allowed harvesting after treatment at a depuration facility or planting on a relay lot. A pump station in Margate has also had frequent problems with overflows.

Marinas have been identified as potentially affecting the suitability of shellfish growing areas. All confines of a marina are automatically designated as *Prohibited*. A buffer area may also be included in the *Prohibited* classification accounting for the size of the marina and the size of the boats. This is a precautionary measure similar to the buffer around sewage outfalls.

Recreational activities may also have a seasonal impact on these waters. In 1997, "No Discharge Zones" under the Clean Vessels Act were instituted in some areas such as the Manasquan River. The discharging of human waste from boats into the estuary/bays in these areas is prohibited. These requirements are expected to facilitate further improvements in water quality in the estuaries. In addition, many storm drains discharge to these waters. See figure A5.2.3-1. Wildlife, especially waterfowl, may also be sources of fecal pollution

### 7.2.4 Maintaining and Improving Harvestable Areas

In order to reach the goal of 90% harvestable waters by 2005, NJDEP developed a Shellfish Action Plan, which is summarized in Table 7.2.4-1 below. The plan addresses reduction in prohibited areas around point sources and management of non-point sources. In addition, a detailed case study is provided to demonstrate techniques of pollution source identification. Future 305(b) Reports will describe changes in water quality and shellfish harvest classifications as a result of mitigation activities.

**Table 7.2.4-1 Shellfish Action Plan**

| Location | % Harvest | Success Probability | Action | Est. Time (yrs) | Est. Cost | Funding Source |
|---|---|---|---|---|---|---|
| Sandy Hook | 88.2 | High | More intensive sampling to enhance database for classification analysis | 2 | $2,490 | NJDEP |
| OCUA-No. | 88.5 | High | ID new landmarks for closure delineation | 1 | $0 | |
| Long Branch-Atlantic Ocean | 88.8 | High | Installation/upgrade of alarms at WWTP | 4 | $0 | Utilities Authority |
| Flynns Knoll | 89.7 | High | Toxics testing of shellfish to confirm acceptable levels | 1 | $15,800<br>$1,200 | USEPA2<br>NJDEP |
| Toms River | 89.9 | High | Shoreline survey for NSSP Report | 1 | $0 | |
| Sea Isle City | 89.9 | High | NPS source ID & correction | 3 | $31,928 | Not known |
| Sandy Hook | 90.5 | Mod. | More intensive sampling to enhance database for classification analysis | 2 | $2,490 | NJDEP |

**New Jersey's Nonpoint Source Monitoring Strategy**

New Jersey has developed a strategy to address non-point pollution (NJDEP, 1997) which incorporates the following steps: Identify a water quality use impairment; evaluate Statewide datasets to identify spatial extent of concern; and, perform more intensive monitoring in these areas to more closely define the source of the pollution. The State then works, through county and local agencies to take corrective measures to reduce or eliminate the pollution source. Additional monitoring is to evaluate the effectiveness of the corrective measures that were implemented.

Shellfish harvesting restrictions provide a good example of how this process is being applied. Restrictions on shellfish harvesting in New Jersey bays are almost entirely due to nonpoint source pollution. Since wastewater discharges have been relocated to ocean outfalls, very few point sources discharge to the back bays. An analysis of water quality monitoring data showed that in many areas, degradation of water quality was related to rainfall. Figure 1 shows an analysis of 10 years of data for fecal coliform bacteria relative to rainfall Areas highlighted are waters where fecal coliform levels were found to increase following a storm event. Figure 7.2.4-2 shows a close-up of a portion of Figure 7.2.4-1. Figure 7.2.4-2 more clearly illustrates near ore areas where the response to stormwater is more intense. These are areas of concern that coincide with waters restricted for shellfish harvest.

An initial pollution source survey identified many potential sources in the watershed of the affected area (see Figure 7.2.4-3). These potential sources included wildlife, urban runoff, marinas, dog waste, illegal discharges, and storm water outfalls.

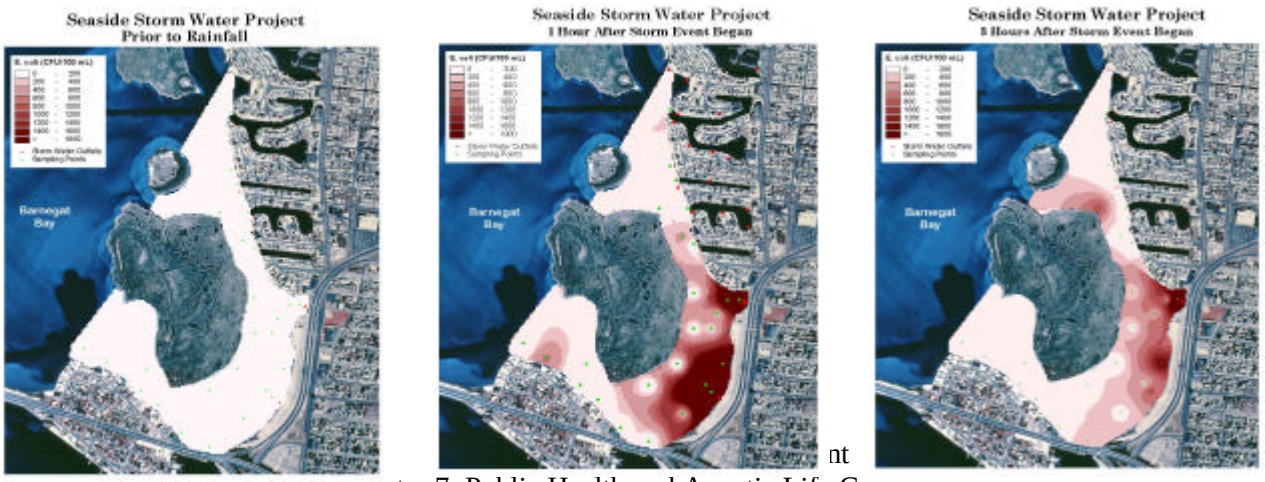
Intensive monitoring was performed under storm conditions to narrow down the list of potential sources. Sampling for coliform bacteria was performed immediately prior to a storm event and then once each hour for three hours following the onset of rainfall. Results of this monitoring are shown in Figure7.2.4-4. As can be seen from this analysis, two storm water outfalls were the primary contributors of coliform bacteria during storm events. These two outfalls were identified out of about 20 other outfalls and numerous other potential sources of coliform bacteria in the vicinity of the impacted waters.

The intensive monitoring allows us to focus resources on correcting the actual sources of the problem. The Department has recently received a proposal from the municipality to take corrective actions on these stormwater outfalls. Once this corrective action has been taken, further monitoring will be used to measure the effectiveness of the corrective action. If successful, this process will lead to a removal of restrictions to shellfish harvesting (the targeted use impairment). Two other similar projects are currently underway in New Jersey's coastal waters and additional projects are being planned.

Removal of restrictions on shellfish harvest is one possible benefit from the use of the NPS Monitoring Strategy. However, this same strategy might also be applied to other water quality-related use impairments such as bathing beach closures, nutrients and toxic pollutants.

**Figure 7.2.4-3 Numerous potential pollution sources that were identified prior to intensive monitoring.**


**Figure 7.2.4-4. Progression of fecal coliform levels in coastal waters during a storm event.**

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## 7.3 Issues of Special Concern

### 7.3.1 Lead in Surface Waters Near Firing Ranges (Mirror Lake Investigation)

Recent findings (June 23, 1999) have shown lead (Pb) contamination in Mirror and Hanover Lakes in Pemberton Township, Burlington County. Elevated levels of lead have been detected in sediment samples collected from the outfall of Hanover Lake (on Fort Dix-DOD property) and at one location in Mirror Lake, which is approximately one mile downstream of Hanover Lake. Mirror Lake is located in a residential area and is used for recreational purposes, including swimming. In a series of sampling events the sources of the lead contamination were shown to be the firing ranges at the Fort Dix military base.

On November 10, 1998, the New Jersey Department of Environmental Protection (NJDEP) conducted sampling of the north and south branches of the Rancocas Creek as part of its metals monitoring program. The sample result for the outfall of Hanover Lake indicated the presence of lead (Pb) at 6,970 milligrams per kilogram (parts per million, or ppm). The expected level of lead in a sediment sample collected from a developed area is approximately 50 parts per million. In addition, lead was detected in a surface water sample collected at the same location at 20 micrograms per kilogram (parts per billion, or ppb), which is four times the New Jersey Surface Water Quality Standard of 5 ppb for this contaminant. NJDEP calculated the values for lead in lake sediments and surface water that could cause acute toxicity from direct exposure (i.e., ingestion of sediments while swimming or by playing on a shore or beach) and indirect exposure (consumption of fish that have bioaccumulated lead). The levels for acute toxicity from direct exposure while swimming were 1,100 ppm in the sediments and 6.8 ppm in the surface water. NJDEP then conducted sampling in twelve areas in and around Mirror Lake. Out of the twelve locations sampled, one location, believed to be in an area not used for swimming, had elevated levels of lead (1,660 ppm) in lakeshore sediments. All the other areas were below levels of concern. The County Health Department posted this area for restricted swimming.

In addition, NJDEP worked with Fort Dix Environmental Staff in delineating the nature and extent of the lead contamination including assisting them in designing a Remedial Investigation and Focused Feasibility Study which showed elevated levels of lead in proximity to some of its firing ranges and the presence the improper use of a firing range berm for stream bank restoration at the dam below Hanover Lake. This site contained numerous bullets (Pb) and casing fragments (Cu) which were also present in the streambed. Responsibility for further delineation and remediation of these locations has been shifter to EPA region 2 personnel and are being carried out by contractors to DOD and Ft. Dix's Environmental Department.

#### 7.3.1.2 Fish Consumption at Mirror lake

Fish tissue data was collected from Mirror Lake to evaluate potential Pb consumption in fish from Mirror Lake. Sampling for this evaluation included recreationally targeted (i.e., sport) fish, that were likely to be consumed by humans, and included largemouth bass (*Micropterus salmoides*) and brown bullhead (*Ameiurus nebulosus)*. A total of 10 largemouth bass and 2 brown bullhead were collected and processed for analysis. The New Jersey Department of Health and Senior Services (NJDHSS) laboratory analyzed the fish samples for lead (Pb), mercury (Hg),

and copper (Cu). The average tissue concentration of the three metals were 0.3 µg Pb/g fish, 0.3 µg Hg/g fish, and 0.2 µg Cu/g fish. The 95% upper confidence interval for Pb was calculated to be 0.5 µg Pb/g fish.

The evaluation indicated that concentrations of Pb in Mirror Lake fish were below the calculated fish Pb concentration of 4.3 µg Pb/g fish for consumption by young children (the most sensitive age group). A fish advisory is already in place for Hg and the observed concentrations confirmed that Hg levels are elevated in the fish collected from Mirror Lake. Copper is an essential nutrient to humans and levels of Cu in fish were below the recommended dietary allowance (RDA). Therefore, the concentrations of Cu in fish are not a human consumption concern.

Conclusions: Concentrations of Pb and Cu in fish from Mirror Lake are below levels of concern for consumption by humans and do not pose a significant health risk. Levels of Hg in fish from this water body confirm the need for the existing consumption advisory.

### 7.3.2 Harmful Algal Blooms (HABs)

Harmful algal blooms (HABs) include species of microscopic, usually single celled algal plants that live in estuarine and marine waters. A "bloom" occurs when algae grow very quickly or "bloom" and accumulate into dense visible patches near the surface of the water. Only a few of the many thousands of species of algae are associated regularly with toxic or harmful algal blooms. When a given species of algae blooms and imparts a particular color to the water, due to the pigments they contain, they are known as "red tides", "green tides", or "brown tides". These algal blooms can also cause numerous ecological and/or human health problems due to the toxins produced by the species and their potential bioaccumulation in the food web, or due to the degradation of blooms which may cause hypoxic or low dissolved oxygen levels in water.

#### 7.3.2.1 Brown Tides

In 1988 a newly described golden brown algae, *Aureococcus anophagefferens*, was determined to be the cause of harmful blooms in Long Island (NY), Peconic (NY) and Narragansett (RI) Bays. However, it was not until 1995 that it was first identified in Barnegat Bay (NJ). Generally, brown tide blooms have not posed a health risk to humans. However there can be significant ecological impacts from brown tide blooms. The 1995 brown tide bloom in Barnegat Bay was associated with reduced juvenile hard clam, *Mercenaria mercenaria*, growth as reported by the commercial aquaculture facility for hard clams (e.g., Biosphere, Inc.) in Tuckerton. Another bloom appeared in 1999, but previous blooms have not been well documented and little attempt been made to gather data which might help understand their causes. Therefore, the Division of Science, Research and Technology is conducting an assessment to confirm the presence of the brown tide blooms in Barnegat Bay in order to find out more about the spatial and temporal occurrences of the blooms and what might be promoting the blooms. The Department effort will team with scientists at Rutgers University and elsewhere.

Brown tide devastated the scallop industry in Long Island bays in the early 1980s but after years of research, little is known about direct links between cause and effect of the blooms. There are numerous hypotheses that have been tested concerning the causes. Higher salinities are associated with the promotion of brown tide blooms but other physical, chemical and biological

factors, such as nutrient loading rates may prove to be important. In Long Island bays, physical factors such as shallow bays, low water flushing rates, and longer periods in which the water resides in the bay, appear more likely to promote brown tide blooms. Barnegat Bay is a shallow bay (av. 4 ft. depth), with higher salinities and the southern part of the Bay, where the brown tide occurs, has low flushing rates and long water residence times – similar to Long Island bays experiencing the same blooms.

For the first time, in FY 2000, the NJDEP is counting the brown tide organism, *A. anophagefferens*, in water samples using a new method called monoclonal analysis (NJDEP/DSRT Brown Tide Assessment Project). This procedure, developed by Dr. David Caron of the University of Southern California, is highly accurate and precise and provides results within one day of sampling. As the NJDEP collects data, other scientists are collecting data on natural resources (e.g., hard clams and eelgrass) as well as other factors possibly relating to the occurrence of the brown tide bloom in the Bay. The NJDEP hopes to identify factors associated with or resulting from these blooms which will assist in managing these blooms. For example, Dr. Mary Downes Gastrich (NJDEP/DSRT), Dr. O.R. Anderson (Columbia University) and Dr. Elizabeth Cosper (Coastal Environmental Studies) are assessing the presence of viruses in natural populations of *A. anophagefferens* in Barnegat Bay and the possible role that viruses may play in diminishing or controlling blooms.

A significant brown tide bloom is occurring this year FY 2000 in Little Egg Harbor in southern Barnegat Bay. The highest counts of the brown tide alga, *Aureococcus anophagefferens,* were at one and a half million ($1.56 \times 10^6$) cells per milliliter to over two million per milliliter in Little Egg Harbor on June 8 and the week of June12. Algal counts greater than one million cells per milliliter are considered full bloom conditions. The Bureau of Shellfisheries reports that shellfishermen are observing slow growth in planted hard clams due to the cessation of feeding by clams during brown tide blooms. Biosphere, Inc., a commercial hard clam culture facility has reported that they had to relocate their hard clams to another area because of the brown tide bloom influence during June 2000.

#### 7.3.2.2 *Pfiesteria* Monitoring and Planning

*Pfiesteria piscicida* and *Pfiesteria shumwayae* are single cell organisms that are able to swim in water and remain dormant in bottom sediment in certain areas of marine estuaries (back bays and tidal tributaries). They are not found in fresh water. *Pfiesteria* appear to be a natural part of the marine environment. *Pfiesteria* are not normally toxic but, under certain environmental conditions, are able to prey upon and kill fish and other marine animals through the release of toxic chemicals. The environmental conditions that allow a toxic outbreak of *Pfiesteria* to develop are not fully understood. However, toxic outbreaks have always been associated with the presence of high densities of fish (*e.g.*, Atlantic menhaden [*Brevoortia tyrannus*]) and warm, brackish, poorly flushed waters with high levels of nutrients.

A NJDEP *Pfiesteria* Contingency Plan is in place for New Jersey waters. It was crafted by personnel from NJDEP the NJ Department of Health and Senior Services (NJDHSS). A draft of this plan was used in response to a September 1999 Tuckahoe River fish-kill and worked well. The Plan will be used by the NJDEP and the NJDHSS to protect the public and state-sampling

personnel in the event that a fish kill occurs in which there is evidence that *Pfiesteria* may be involved.

On August 17, 23, 24, and 25th 1999 NJDEP's Division of Science, Research and Technology collected water column samples from 20 estuary sites in NJ and sent these samples to the University of North Carolina at Greensboro for analysis for *Pfiesteria piscicida*, *Pfiesteria shumwayae* [*nee P. piscicida* species B], and *Cryptoperidiniopsis* (an organism responsible for a fish kill in Florida and a close relative of *P. piscicida*) using a new gene probe assay. The assay is able to detect ribosomal DNA of these organisms, if present (Oldach *et. al.*, 2000).

The sites sampled were a subset of NJDEP, Office of Water Monitoring Management, Bureau of Marine Water Monitoring's 260 Nutrient Biomonitoring Stations. The sites selected were from: Raritan Bay (2 sites), Navesink - Shrewsbury River estuary (4 sites), Metedeconk River estuary (2 sites), Barnegat Bay (2 sites), Mullica River estuary (2 sites), Egg Harbor/Tuckahoe River estuary (2 sites), and several Delaware Bay estuary sites between the Maurice and Salem Rivers (6 sites)(Figure 1). The sites were selected by DSRT using a map of two GIS coverages: the Nutrient Biomonitoring Network coverage and a coverage created by the Bureau of Marine Water Monitoring, showing estuary areas that have a combination of environmental conditions (salinity, nitrogen, phosphate, flushing, etc.) that would have a higher than average potential in NJ of being conducive to *Pfiesteria* growth.

Sampling took place toward the end of a multi-month period of drought. The test results showed that none of the three organisms were found in any of the samples. One of the samples was collected from the Tuckahoe River; approximately 9 miles east (downstream) from the site of a later fish kill. A re-analysis of an archived sample from the Tuckahoe River site was also negative for these organisms.

On November 10 and 17, 1999, DSRT collected 15 water column and 15 sediment samples from 7 estuary locations in New Jersey, including the Tuckahoe River site of the 9/99 fish kill. Five sample sites were Nutrient Biomonitoring Station sites that had been previously sampled in August. Four sites were Nutrient Biomonitoring sites that had not been previously sampled and six sites, including the previously sampled fish kill site, were not Nutrient Biomonitoring sites. The estuary locations sampled were the Mullica River (3 sites), the Egg Harbor River (2 sites), the Tuckahoe River (4 sites), the Maurice River (2 sites), the Dividing Creek (1 site), the Cohansey River (2 sites), and Stowe Creek (1 site). The test results showed that none of the three organisms were found in any of the samples.

It is hopeful that DSRT will collect additional water and sediment samples during summer 2000. Rather than sampling fixed NJDEP sampling locations as was done (for the most part) in past surveys, sampling will be targeted at estuary locations with high levels of organic matter (as determined by visible inspection of ponar grab samples) and salinity that approach the optimum salinity for *Pfiesteria* (15 ppt), *Aphanomyces* (2-10 ppt), and juvenile Atlantic menhaden growth. Areas with comparatively lower flushing rates will be targeted, as will sites with higher than average potentials for nutrient loading.